Building the Casaccia gamma field. Nuclear energy, Cold War and the transnational circulation of scientific knowledge in Italy (1955-1960)

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The article will focus on the mutagenesis programme in agriculture implemented by the Italian Atomic Energy Commission, starting from 1955, through the establishment of a specific technological and experimental system: the so-called "gamma field", a piece of agricultural land with a radioisotope of Cobalt-60 at the centre. The Cobalt-60 would emit constant radiation, which would bombard the specimens planted in concentric circles around the source, inducing genetic mutations. The Italian gamma field went into operation in January 1960 at the Casaccia Laboratory, about twenty miles north of Rome, with a radiation device made available by the US Government for the Atoms for Peace programme This article will analyse, first of all, how the American experimental model of mutation breeding was translated into the Italian context, becoming instrumental for the establishment of plant genetics within the local academic system; secondly, it will describe how the sociotechnical imaginary embodied by the gamma field was part and parcel of this process of discipline-building and scientific demarcation.
Key words: Cold War, Atoms for Peace, Nuclear energy, Agriculture, Plant breeding, Genetics

It was a round-shaped field, covering a surface of some six thousand square metres: at the centre, in a hole made of concrete walls, the radiation unit that the United States had donated in 1958 as part of the Atoms for Peace programme. The unit was composed of a lead cylinder that weighed about a ton, which contained a radioactive source: two Cobalt-60 rings, approximately twenty centimetres long. With the help of a steel tree and a special radio-controlled system, a control cabin placed at the outer edge of the field — a building made of concrete and pot-metal glass — regulated the source's extraction from its container and the subsequent radiation, 20 hours a day, of the surrounding plants. The field was circumscribed by an earthwork of over five metres high, and could be accessed via an opening in the earthwork, guarded by gates that were operated by a radio-controlled blockage and connected to the movements of the radioactive source. The opening itself was shielded by a high concrete wall.

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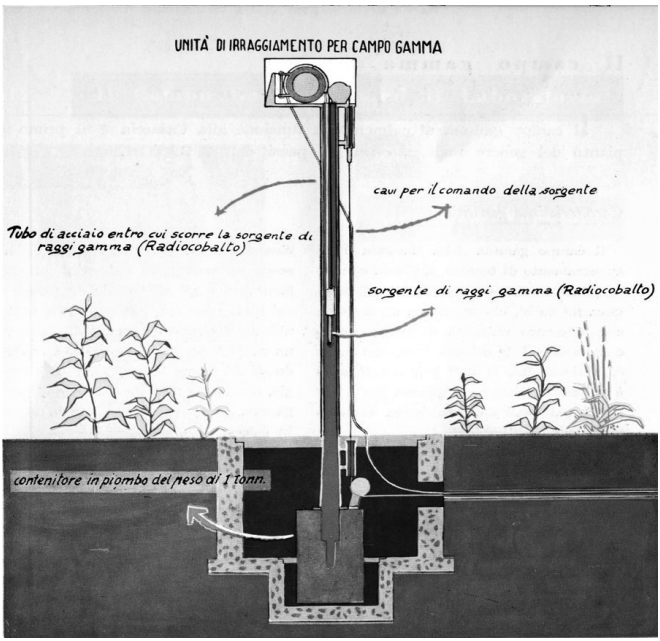
Fig. 1 — Luigi Rossi private archive, Cobalt-60 source of the gamma field before its installation (1959)



The gamma field — or "campo gamma", as it was called in Italian — arose well in the midst of the Roman countryside, and was part of the Laboratory for nuclear energy applications in agriculture. The latter had been created by the Italian Atomic Energy Commission (Comitato nazionale per le ricerche nucleari, hereafter CNRN — later changed in CNEN) at the Casaccia Nuclear research centre in 1960. The area distanced 28 kilometres from Rome and five kilometres from Anguillara, a hamlet on the bank of the Bracciano lake.[1]

No visible trace of the gamma field remains at the Laboratory's current site, which is managed by the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), as it was entirely dismantled in the wake of the anti-nuclear referenda of 1987. Hidden by trees and high grass, the site of the former gamma field has become a non-place of collective memory, whose deafening silence clashes with its complex and rich, national as well as international, history.

[1] For a general overview of the Italian nuclear programme, with references also to Casaccia, see in particular: Giovanni Paoloni (ed.), *Energia, ambiente, innovazione: dal Cnrn all'Enea*, Rome-Bari, Laterza, 1992; Barbara Curli, *Il progetto nucleare italiano (1952-1964). Conversazioni con Felice Ippolito*, Soveria Mannelli, Rubbettino, 2000; G. Paoloni, *Il nucleare in Italia*, Rome, Enel, 2008.

Fig. 2 — Luigi Rossi private archive, transportation – by means of a tractor – of the Cobalt-60 source of the gamma field (1959)

By focusing my analysis on a technological artefact (the gamma field), in this essay I aim to stress its relevance not only for the study of the relationship between nuclear energy and agriculture in post-WW2 Italy, but also for the understanding of broader issues concerning the impact of the Cold War on the Italian scientific research system.

The first part of this essay is related to the watershed represented by the *Atoms for Peace* programme, launched in December 1953 by US President Dwight Eisenhower during a famous speech at the UN General Assembly. *Atoms for Peace* was a polyvalent policy initiative: it was an instrument of American foreign policy and "psychological warfare" (the "struggle for the minds and wills of men" in competition with the Soviet Union), but it also aimed at exerting control over nuclear technologies at an international level and at providing scientific intelligence gathering; as such the promotion of the benign atom placed not only physics and engineering but also biology, medicine and agriculture in a global technological, scientific and socio-political context.[2] The transnational circulation of isotopes, knowledge and technologies linked to the civil applications of nuclear energy recently attracted the attention of historiography, especially in relation to biology and medicine. Existing scholarship has highlighted not only the role of atomic programmes as strategic tools of international diplomacy, but also their impact on the development of a number of scientific areas: from genetics to biochemistry, from ecology

[2] John Krige, *Atoms for Peace, scientific internationalism, and scientific intelligence*, "Osiris", 2006, n. 1, pp. 161-181.

to the study of cancer.[3] Agriculture, however, has remained a rather neglected territory.[4]

The aim of this essay is to fill this gap and demonstrate how *Atoms for Peace*, as part of the co-produced and consensual process of constructing American hegemony in the fields of Western European science and technology,[5] provided Italian scientific elites with economic, political and social resources that enabled them to pursue their own research agendas while reinforcing their Atlantic connections. From this perspective, I consider the gamma field — and, more generally, the launch of a programme for the use of nuclear energy in agriculture — an essential factor in the process of organising and institutionalising plant genetics in Italy during the second post-war period, as well as in the definition of a research model aimed at bringing "pure" and "applied" research together.

The lack of scholarship on the effects of *Atoms for Peace* for agriculture is even less understandable if we think of the pervasiveness and political effectiveness that marked the expectations raised by nuclear energy applications in the agricultural field: those of achieving control over nature, speeding up evolution and designing plant organisms with precise political, economic and social functions. This Promethean rhetoric leads us to the second historiographical theme of this essay: the gamma field as an example of sociotechnical imaginary in the field of nuclear energy.[6] In the following pages I aim to demonstrate how, from the very start and despite the fact that the mutation breeding programme in Italy largely developed without the direct use of gamma rays, other sources and different methods of radiation being preferred (e.g., x-rays and thermal neutrons radiated on seeds), the gamma field nevertheless emerged as an undisputed protagonist, as the icon of a new era (that of the

[3] Among the many studies on this subject the most essential one is: Angela N.H. Creager, *Life atomic. A history of radioisotopes in science and medicine*, Chicago and London, The University of Chicago Press, 2013.

[4] On this issue see: Helen Anne Curry, *Evolution made to order. Plant breeding and technological innovation in Twentieth-Century America*, Chicago and London, The University of Chicago Press, 2016; Jacob Darwin Hamblin, *Let there be light… and bread: the United Nations, the developing world, and atomic energy's Green Revolution*, "History and Technology", 2009, n. 1, pp. 25-48; Jacob Darwin Hamblin, *Quickening nature's pulse: atomic agriculture at the International Atomic Energy Agency*, "Dynamis", 2015, n. 2, pp. 389-408; Karin Zachmann, *Peaceful atoms in agriculture and food: how the politics of the Cold War shaped agricultural research using isotopes and radiation in postwar divided Germany*, "Dynamis", 2015, n. 2, pp. 307-331; Karin Zachmann, *Risky rays for an improved food supply? National and transnational food irradiation research as a Cold War recipe*, Preprint 2, Munich, Deutsches Museum, 2013; Neil Oatsvall, *Atomic agriculture: Policy making, food production, and nuclear technologies in the United States, 1945-1960*, "Agricultural History", 2014, vol. 88, n. 3, pp. 368-387.

[5] John Krige, *American hegemony and the postwar reconstruction of science in Europe*, Cambridge, MA., MIT Press, 2008.

[6] Sheila Jasanoff, Sang Hyun Kim, *Dreamscapes of modernity. Sociotechnical imaginaries and the fabrication of power*, Chicago and London, The University of Chicago Press, 2015.

"atomic farmer" or the "atomic garden"), and as the technological infrastructure providing political, economic and cultural legitimacy to the burgeoning field of plant genetics in Italy.

Speeding up the rhythm of nature

In July 1927 a short article published in the journal *Science*, titled "Artificial Transmutation of the Gene", became an international news story.[7] The author was the American *Drosophila* geneticist Hermann J. Muller, a collaborator of Thomas Morgan at Columbia University and professor at the University of Texas. Muller claimed that gene mutations could be produced rapidly and artificially in a laboratory through x-ray treatment.[8] Almost simultaneously, the agronomist Lewis John Stadler and the botanist Thomas Harper Goodspeed proved that it was possible to use ionising radiations as mutagens in plant organisms: the former found that the frequency of mutation increased if he radiated seeds of grass plants with x-rays; the latter obtained similar results when he exposed seeds and pollens of tobacco to x-rays.

While still unable to compete with traditional methods of genetic improvement (e.g., cross-breeding, genetic selection) on a productive level, throughout the 1930s the first research programmes on radioinduced mutation breeding began to spread in the United States and Europe. Germany took the lead, with Hans Stubbe's works on the snapdragon; Dutch scientists studied the cross-breeding of the mutant "Chlorina" in the tobacco plants of Java; in Sweden, a research group directed by Herman Nilsson-Ehle and — subsequently — by his pupil Åke Gustafsson worked to improve barley.[9]

In Italy, the skilful and self-taught agronomist Alberto Pirovano (constitutor of the famous "uva Italia") began studying — from 1912 onwards — the mutagenic effects of electromagnetic energy, x-rays (to a lesser degree) and radium on plant organisms.[10] After becoming director of the Institute for Fruit Growing and Electrogenetics in 1924 (initially in Belgirate, from 1927 onwards in Rome), Pirovano expanded the range of his experiments, developing his own "electrogenetics" into a more general mutation theory — the so-called *jonolisi*

[7] Hermann J. Muller, *Artificial transmutation of the gene*, "Science", 22 July 1927, vol. 66, n. 1699, pp. 84-87.

[8] On Muller's role with regard to eugenics, Lysenkoism and the Cold War, see in particular William deJong-Lambert, *Hermann J. Muller and the biopolitics of mutations and heredity*, in Luis Campos, Alexander von Schwerin (eds.), *Making mutations: objects, practices, contexts*, Berlin, Max Planck Institute for the History of Science, 2010 (Preprint 393), pp. 151-175.

[9] A.M. van Harten, *Mutation breeding. Theory and practical applications*, Cambridge, Cambridge University Press, 1998.

[10] See, especially, Alberto Pirovano, *La mutazione elettrica nelle specie botaniche e la disciplina dell'eredità nell'ibridazione*, Milan, Hoepli, 1922. On Pirovano's electrogenetics see: Luca Iori, *Electrical Hybrids*, in Giuliano Pancaldi (ed.), *Electricity and life. Episodes in the history of hybrid objects*, Bologna, CIS, 2011, pp. 65-92.

— which rejected Morgan's chromosomal theory, while combining elements from Mendelism, Lamarckism, Weissmanism and Devriesian mutationism.[11]

As the case of Pirovano's electrogenetics clearly shows, the lack of a mutation breeding programme in interwar Italy rested primarily on the limited reception of Mendelism and chromosomal theory. Notwithstanding the reference to "genetics" in its title, the National Institute of Genetics and Cereal Research of Rome — the most important institution in the area of plant breeding, founded by the Italian agronomist Nazareno Strampelli in 1919 — did not, in fact, contribute significantly to the development of a Mendelian agenda in interwar Italian agriculture. The cultural and scientific weaknesses of Mendelism was exacerbated by the institutional distance between the Faculties of Science, on the one hand, and, on the other, the Faculties of Agriculture and the agricultural experimental stations of the Ministry of Agriculture and Forestry (hereafter MAF), where genetics and statistics courses were often completely lacking. A similar persistent educational deficit contributed to reinforce the tensions between counterposed experimental cultures. Indeed, contrary to the geneticists, Italian plant breeders and agronomists — including those not hostile to Mendelism — considered not the gene but the "variety" the principal unit of analysis and manipulation.[12]

From this perspective, the establishment in Italy of the first chairs in genetics within the Faculties of Science — respectively in Naples in 1944, with Giuseppe Montalenti; in Pavia in 1948, with Adriano Buzzati-Traverso; in Milan, in the same year, with Claudio Barigozzi — marked an important turning point.[13] In fact, the process of institutionalisation of Italian genetics, which occurred between 1948 and 1953, coincided with the tormented construction of an autonomous scientific field, defined by precise epistemological and disciplinary boundaries between "academic" genetics (described as "pure", "theoretical", "basic") and the "applied" research of its "foster parents", namely eugenics and agriculture.[14] In those same years, this process gained an

[11] On this issue see, in particular: Alessandro Volpone, *Gli inizi della genetica in Italia*, Bari, Cacucci Editore, 2008, pp. 76-77. In his *Mutationstheorie* (1901-1903), Dutch botanist Hugo De Vries (1848-1935) conceived "mutation" as a sudden change that was able to explain, on the evolutionary level, the formation of new species.

[12] For references to other national contexts see Cristophe Bonneuil, *Mendelism, plant breeding and experimental cultures: agriculture and the development of genetics in France*, "Journal of the History of Biology", 2006, vol. 39, n. 2, pp. 281-308; Paolo Palladino, *Between craft and science. Plant breeding, mendelian genetics, and British universities, 1900-1920*, "Technology and Culture", 1993, vol. 34, n. 2, pp. 300-323.

[13] Francesco Cassata, *The struggle for authority over Italian genetics: the Ninth International Congress of Genetics in Bellagio, 1948-53*, in Bernd Gausemeier, Staffan Müller-Wille, Edmund Ramsden (eds.), *Human heredity in the Twentieth Century*, London, Pickering & Chatto, 2014, pp. 217-228.

[14] On this process of scientific demarcation, for the interwar period see Nikolai Krementsov, *International science between the World Wars: the case of genetics*, Abingdon and New York, Routledge, 2005.

international political dimension, closely connected to the incoming Cold War. Genetics and agriculture soon became a not only scientific point of contention, but also a politico-ideological one. While in 1948 an induced-mutation breeding programme in agriculture was launched at the laboratory of the United States Atomic Energy Commission (hereafter USAEC) of Brookhaven, in the Soviet Union Joseph Stalin formally approved the Michurinist "agrobiology" of agronomist Trofim Denisovich Lysenko: a vitalistic and neolamarckian theory, which openly contradicted the basic tenets of genetics, including Gregor Mendel's laws, Thomas Morgan's chromosomal theory and the very concept of the gene as a material unit of heredity. In July and August 1948, the escalating Cold War confrontation was translated into the opposition between two antonymic theories and labels: on the one side, Soviet biology (scientific, materialistic, creative, productive, progressive, Darwinist "Micurinist biology); on the other, Western biology (anti-scientific, idealistic, scholastic, sterile, anti-Darwinist "Mendelism-Morganism").[15]

To understand the interdependence between the scientific and disciplinary boundary-work of Italian genetics and the development of the Cold War confrontation, especially in the area of plant genetics, it might be useful to trace the biographical as well as disciplinary trajectories of two main figures of this transition phase. One is the zoologist Carlo Jucci, who in 1954 founded the Italian Society of Plant Genetics (SIGA); the other is the *Drosophila* geneticist Adriano Buzzati-Traverso, one of the architects of Modern synthesis — according to Ernst Mayr's reconstruction.

As a Rockefeller fellow in 1927, Carlo Jucci had supported the initial steps of Buzzati-Traverso's career in Pavia. In the early post-war years, particularly after the appointment of Buzzati-Traverso as full professor in Pavia, in 1948, their personal and academic relationship worsened rapidly. The tension materialised in an institutional opposition: Buzzati-Traverso was head of the Institute of Genetics, while Jucci established a Centre of Genetics within the Institute of Zoology, with funds from the CNR. Their research agendas also began to diverge: while Buzzati-Traverso was increasingly engaged in "theoretical" issues of radiobiology and biophysics, Jucci progressively moved towards the field of "applied" genetics. In 1946, he founded *Genetica Agraria* [Plant Genetics], a journal of "genetics *applied* to agriculture", whose editorial board did not include the three Italian academic geneticists. In April 1950, while Italian academic geneticists eventually left the Italian Society of Genetics and Eugenics (hereafter SIGE) after two years of intense disputes with its President, the statistician and eugenicist Corrado Gini, Jucci — SIGE's secretary-general ever since 1948 — accepted the presidency over a new SIGE

[15] Between 1929 e il 1935, Lysenko's agronomic concepts of vernalisation expanded into a broad theoretical doctrine, which the Ukrainian agronomist renamed "agrobiology" or "michurinism", after Ivan V. Michurin (1855-1935), an amateur plant breeder with the status of a national hero in the Soviet Union in the early 1930s.

section dedicated to "*applied* genetics", bringing together SIGE agronomists, breeders, entomologists and plant pathologists.

Two months later, in May and June 1950, the refusal of the Italian academic geneticists to join the First Congress of Plant Genetics — which Jucci had organised in Rieti — further underscored the disciplinary fracture in the field of genetics. During the Congress, which had an important international dimension and was dominated — on the national side — by technicians and agronomists rather than by geneticists,[16] Jucci made the following acknowledgment in his closing speech:

> As a theoretical geneticist I truly cannot claim to be a hundred percent pure. Thirty years ago I started studying silkworms, and although I have always been fascinated more by the general scientific aspects of the problems than by their practical applications, for at least 15 years now I have felt that it is my duty to gain exact awareness of the problems of Italian sericulture and to try and make a contribution to their resolution (…).
> Having extended my interest — and especially that of my School — from silkworms to other work material, including plants (…) I have become ever more conscious of the vital importance of a close collaboration between laboratory research and practical improvement activities, and within the boundaries of my modest possibilities I have actively sought to encourage it, always contesting the excessively individualist mindset that tends to prevail among us as also the shortsightedness of the powers tha -be who primarily have the important and delicate task to promote the aforestated collaboration and integration.[17]

By contrast, Adriano Buzzati-Traverso — talking about genetic improvement during a 1949 conference at the Lombard Society of Agriculture — distinguished between "genetics and genetics", that is, between a "pure", "theoretical" dimension and an "applied", empirical approach:

> I wish to draw your attention to the fact that, so to say, there is genetics and there is genetics. By this I mostly mean — especially in an agricultural context — any kind of procedure aimed at improving the qualities of seeds or livestock. Man has had recourse to this type of genetic experiments for a very long time now, that is, ever since he started growing specific plants in view of a more secure livelihood; even the practices of selection that have developed especially during the past century and in the first decades of the current one — the only practices to have been applied in Italy — may fall under this generic term. However, from about 1910 onwards a revolution has occurred in biology, thanks to the development of modern genetics (…). I now have the impression that those working on seed improvement in Italy haven't yet noted this revolution, and therefore continue to use those empirical criteria that once worked fine but will no longer do.[18]

[16] Gustafsson and Akerman arrived from Sweden. Other conference attendees included António Sousa da Câmara, director of the National Agronomic Research Station of Portugal; Thomas James Jenkin, director of the *Welsh Plant Breeding Station* in Aberystwyth; and Ronald A. Silow, from the Agricultural Division of the UN Food and Agriculture Organization (hereafter FAO).

[17] Carlo Jucci, *Genetica e agricoltura*, in *Atti del convegno di genetica agraria*, Tipografia del Libro, Pavia 1951, p. 461.

[18] Adriano Buzzati-Traverso, *Il problema attuale delle sementi e il loro miglioramento genetico*, "Società Agraria di Lombardia. Conferenze e relazioni", 1950-52, p. 3. On Buzzati-

Officials of the Rockefeller Foundation also noticed the ongoing tensions during their visit to Italian laboratories. The report of the meeting in Milan between Buzzati-Traverso and Gerard R. Pomerat, assistant director of the Rockefeller Foundation's Division of Natural Sciences, on 19 November 1950, not long after the First Congress of Plant Genetics, clearly illustrates the context:

> GRP spends all of a rainy Sunday morning working in diary and then takes Prof. Buzzati-Traverso to lunch. (…) Of the Genetics Station in Rome B.-T. has no very high opinion and he calls De Cillis "an idiot" who does not really know genetics. Doesn't think anything brilliant will come from that outfit. He is not much more optimistic about the Maize Culture Institute. Says Fenaroli has no training in genetics but was put in charge of preparing hybrid corn in Italy. Spent six months in the US and is now testing hybrid corn seeds which were sent here, but doesn't believe anything can be gained by crossing the best US hybrids with the better Italian varieties so obviously he's no very promising plant breeder (B.-T. than *(sic)* states that Jenkins of the USDA was brought here three years ago by the ECA and recommended that it would be best to send over a lot of US hybrids to be tried here on a large scale for subsequent crossing with Italian corn, especially in central Italy, but nothing much was done about it).[19]

In 1950, the Rockefeller Foundation's general evaluation on the state of plant breeding in Italy was rather pessimistic: "As far as GRP [Gerard R. Pomerat] can uncover — Pomerat himself wrote in his diary — there is no real work on plant breeding done in Italian universities and none of the geneticists now active in university posts seem to be interested in the genetics of economically important plants".[20]

In this context, two "hybrid" scientific figures who moved respectively from botany and agronomy to plant genetics and mutation breeding — Francesco D'Amato (1916-1998) and Gian Tommaso Scarascia Mugnozza (1925-2011) — contributed to fill the gap between "pure" and "applied" genetics, by channelling the economic, political and cultural resources of the Italian nuclear programme during the Cold War into a large-scale research agenda including radiobiology, mutagenesis, cytogenetics and breeding.

Born in 1916 in Grumo Appula (Bari), Francesco D'Amato graduated in natural sciences at the University of Pisa and at the Scuola Normale Superiore in 1939. Initially working side by side with Alberto Chiarugi in research on plant embryology and systematic cytology, from the mid-1940s on D'Amato

Traverso, see especially Francesco Cassata, *L'Italia intelligente. Adriano Buzzati-Traverso e il Laboratorio internazionale di genetica e biofisica (1962-69)*, Rome, Donzelli, 2013.

[19] Rockefeller Archive Center (RAC), Rg 12.2, Officers' Diaries, Series 905 Pom 1950, Box 68: "19 November 1950 (Milan)", p. 409. Luigi Fenaroli was the director of the Maize Experimental Station of Bergamo; Ugo De Cillis was the director of the National Institute of Genetics and Cereal Research in Rome. On Fenaroli and, more generally, on the history of hybrid corn in Italy see Emanuele Bernardi, *Il mais "miracoloso". Storia di un'innovazione tra politica, economia e religione*, Rome, Carocci, 2014.

[20] Rockefeller Archive Center (RAC), Rg 12.2, Officers' Diaries, Series 905 Pom 1950, Box 68: "14 November 1950 (Padua)", p. 395.

specialised in the study of the cytophysiological effects of chemical and physical mutagenesis. In this regard, two research visits turned out to be decisive for his training: one in Sweden (1946-1947), at the plant breeding laboratory of the Svalöf experimental station, headed by the plant geneticist Åke Gustafsson; and one in the United Kingdom (1951), at the Department of Cytology and Genetics of the John Innes Horticultural Institution, directed by Cyril D. Darlington.[21]

The scientific collaboration and friendship between D'Amato and Scarascia Mugnozza (hereafter Scarascia) dates back to this early post-war period. Born in Rome in 1925 from a family of southern origins, Scarascia graduated in agrarian sciences at the University of Bari. After receiving a number of grants from the MAF and the CNR, which allowed him to conduct research at the Institute for Fruit Growing and Electrogenetics, in 1950 Scarascia entered in contact with D'Amato and the Botanic Institute of Pisa, where he attended the CNR's local Study Centre for Plant Cytogenetics.

The organisation of the Ninth International Congress of Genetics, held in Bellagio in August 1953, accelerated D'Amato and Scarascia's gradual entry into the circles of "academic" genetics and radiobiology. Two factors fuelled this boundary-work in the field of genetics. On the one hand, the Ninth Congress contributed to deepen the discrepancy between "pure" and "applied" genetics in Italy. In May 1952, in fact, Carlo Jucci — ever more in a collision course with "pure" geneticists — resigned from the presidency of the Congress' executive committee, which was now fully controlled by Buzzati-Traverso, Barigozzi and Montalenti. Furthermore, in February 1953, the "academic" geneticists did not hesitate to reject the proposal — coming from agronomists and breeders (i.e. Ugo De Cillis, Alberto Pirovano, Alviero Dionigi, Alessandro Morettini) — to create an Italian Congress section of "applied genetics":

> There is no applied genetics in Italy — Buzzati-Traverso wrote in a private letter directed at Montalenti in February 1953 — and there is no reason to be ashamed of this. What we should, instead, be ashamed of is that we accepted the intervention of one of these guys, who knows as much about genetics as my granddaughter Lalla does, but she doesn't study natural science: she paints. Why not invite her to give a speech? At least she's a rather pretty girl. I believe that it would be preferable not to have any Italians among the speakers, rather than to have a talk of this kind.[22]

This polarisation increased as a result of Carlo Jucci and Alberto Pirovano's participation — a few months later (October-November 1953) — in a tour to

[21] *Curriculum vitae del dott. Francesco D'Amato*, Pisa, Arti Grafiche Pacini Mariotti, 1957. The collaboration with Gustafsson, which focused on the study of mutability through x-rays in barley, marked an intense research period in D'Amato's career as a plant geneticist: from the analysis of the polyploidy of gammaxene and of the mutagenic activity of acridine derivatives up to the development of a metabolic theory of spontaneous mutation in plants.

[22] Buzzati-Traverso to Montalenti, 2 February 1953, in Archivio Montalenti (Università di Roma La Sapienza, Sezione di Storia della Medicina), b. 28, f. 9.

visit Lysenko's Institute of Genetics and other research centres of Soviet agrobiology, organised by the Italy-Soviet Union Association.[23]

On the other hand, though, the Bellagio Congress represented for D'Amato and Scarascia an occasion to strengthen the relations with "academic" geneticists in Italy as well as on the international arena. It is no coincidence that D'Amato — the only Italian plant geneticist in the Congress organisation — was given the task to coordinate the experimental section of "Demonstrations".[24]

In the wake of the Bellagio Congress, Scarascia's move to the Experimental Tobacco Institute of Rome — first as a research fellow and later as the director of the genetics laboratory — coincided with the inauguration of a line of research focused on the application of ionising radiations in agriculture. In fact, in 1954 Scarascia started to study the spontaneous and induced mutability in *Nicotiana Tabacum* (Virginia tobacco), sending the Atomic Energy Research Establishment of Harwell (in the UK) 20 grams of seeds of different varieties for radiation with thermal neutrons. Moreover, Harwell gave the Experimental Tobacco Institute a radioactive Cobalt capsule to be used for the irradiation of seeds and inflorescences in Italy. Thanks to this collaboration, by 1955 Scarascia completed two important publications on the effects of gamma rays and thermal neutrons on germination, on the chromosomic mutability and on the morphology of tobacco.

In conclusion, as Eisenhower's *Atoms for Peace* programme was gaining momentum through the organisation of the First International Conference on the Peaceful Uses of Atomic Energy, to be held in Geneva in August 1955, the CNRN could count on only two figures of international scientific relevance in the field of mutation breeding in agriculture: Francesco D'Amato and Gian Tommaso Scarascia Mugnozza.

The Italian gamma field between Pisa and Rome

In the summer of 1955, the CNRN indicated Scarascia as a "technical advisor" for the Geneva Conference, for the sector on agriculture. Far from being obvious, this choice was facilitated by the invitation Scarascia had received directly from Harwell, other than by the personal interest of Felice Ippolito. The latter had, in his turn, been solicited by Emilio Battista, undersecretary for the Ministry of Industry and Commerce, and by the Christian Democrat MP Carlo Scarascia Mugnozza, Gian Tommaso's brother. This is confirmed by a letter from Ippolito, dated 25 June 1955:

[23] For a vivid account of the trip, see Orfeo Turno Rotini, *Taccuino sovietico*, Pisa, Giardini, 1955.

[24] *Curriculum del dott. Francesco D'Amato*, p. 5.

Dear Battista,
I received your [letter] of 30 June regarding Dr. G.T. Scarascia and I will do all that is in my power to support him in his aspirations and to help him with his interesting studies.
For now I am delighted to announce that he has already been included as a "technical advisor" in the Italian delegation at the Geneva International Conference, as per his desire.[25]

Apart from the Christian Democrat pressure, the fact that the doors were opened to Scarascia was mostly in virtue of the broad international vision of Felice Ippolito (soon to become the CNRN's General Secretary, in July 1956), his efforts to strengthen the nuclear institution, and his friendship and collaboration with the physicist Edoardo Amaldi — vice president of the CNRN from 1956 onwards — and with Adriano Buzzati-Traverso, who had just come back from the United States and was about to launch the CNRN's radiobiological activities.

In Geneva, agriculture revealed to be one of the fields in which nuclear energy application could have given the most amazing results. According to a number of participants in the 1955 Conference, radioinduced mutation would have "modernised" crops, allowing them to keep up with the changing demands of agricultural production. The peaceful atom in agriculture would have helped increase productivity so as to tackle the growing global demand for food caused by population increase, thus also enabling governments to safeguard national and international security.[26]

Back in Italy, Scarascia wrote a report of over thirty pages long, where he outlined the content of the Geneva communications on the use of ionising radiations and radioisotopes in agriculture. Scarascia's report gave evidence of the plurality of topics discussed during the Conference, summarising them within a synthetic and broad framework.[27] He reserved ample space for plant genetics; in particular, he analysed the two schools — the American and the Swedish one — that had conducted the most "interesting and wide-ranging research" on the use of radioinduced mutation breeding for the improvement of field and tree crops. With regard to both the American and the Swedish research programmes of mutation breeding, Scarascia mostly stressed two aspects. In first instance, the importance of radioinduced mutagenesis in the production of mutants with "utilitarian characteristics" from an agronomic and economic perspective: for example, the new lines of rust-resistant oat obtained in Brookhaven, or the so-called barley mutant "erectoides" from the Swedish programme, high yielding and highly lodging-resistant cultivars. The second

[25] Ippolito to Battista, 25 June 1955, in Archivio Scarascia (Accademia Nazionale delle Scienze detta dei XL, Rome), b. 93.

[26] H.A. Curry, *Evolution made to order*, pp. 192-193.

[27] Gian Tommaso Scarascia, *Isotopi radioattivi*, "La ricerca scientifica", gennaio 1956, a. 26, n. 1, pp. 199-209. Topics included: land and fertilisers; plant nutrition and metabolism; plant genetics; herbicides; parasitology; zootechnical problems; absorption of fission products and ecological problems; food conservation.

fundamental aspect was the close interconnection between pure and applied research, especially in the analysis of the physiological and genetic effects of different types of radiation in relation to the produced mutations.

Scarascia's report concluded by underscoring the "concurring favourable assessment" that had been expressed in Geneva with regard to "applying ionising radiations to plants for mutagenesis in crop improvement". Mutation breeding could, in fact, turn out to be useful both for the introduction of new, convenient mutant varieties and for the potential re-use of radioinduced mutants in subsequent hybridisation programmes:

> A similar method ultimately allows to increase the variability of the agriculturally useful species, so that — even if the production of positive mutations is extremely limited compared to the totality — the multiplication of the mutability will also raise the possibility of obtaining useful mutations, whose acquisition is by now no more than a question of time and efforts[28].

In September 1955, following the Geneva Conference, the dean of the University of Pisa — Enrico Avanzi, Professor of agronomy and Francesco D'Amato's father-in-law — sent the CNRN's President Francesco Giordani the project of a gamma field to be built in Pisa, under the joint direction of the Institute of Agronomy and Herbaceous Crops, directed by Avanzi himself, and the Institute of Genetics, headed by D'Amato.[29] The initiative anticipated Scarascia's involvement from an early stage on, who was described as the "only Italian biologist in Geneva":

> In a meeting held at the headquarters of the Institute of agronomy (which I direct) we have highlighted the opportunity to create, at this university, a radiation field with gamma rays; and, as we concluded this meeting, I felt it was appropriate to entrust the aforementioned Dr. Scarascia (…) with the task of preparing a project for this purpose (…).[30]

Elaborated by Scarascia and D'Amato, and designed in collaboration with the physicist Marcello Conversi and the technical office of the University of Pisa, the Pisan gamma field project entailed the use of a 100-curie Cobalt-60 source to be provided by Harwell. The field — a vast circular area with a radius of 150 metres, for a total of seven hectares and a perimeter of nearly a thousand metres — would be located within the state property of San Rossore, about five kilometres from Pisa, in a place known as "Banditine" that had been rented out to the University of Pisa's Faculty of Agrarian sciences a decade earlier.[31]

[28] G.T. Scarascia, *Isotopi radioattivi*, p. 205.

[29] Avanzi to Giordani, 8 September 1955, in Archivio D'Amato (not inventoried, D'Amato family).

[30] Avanzi to Giordani, 8 September 1955, loc. cit. a nota 27.

[31] *Progetto di "campo gamma" con sorgente di cobalto 60 dell'attività di 100 curie*, n.d. (in reality 1956), in Archivio D'Amato.

In Avanzi's presentation, the recourse to radioinduced mutagenesis was justified by the need to obtain an increase in the available genetic variability.[32] The primary goal of the gamma field was, then, to put into effect a research programme aimed at genetically improving crop varieties of high agricultural interest, "like cereals, grain legumes, fodder, horticultural and floury-type varieties". An additional purpose was that of experimenting with the induction of mutations in spontaneous species, "prone to provide — through the structural change of their hereditary patrimony — beneficial characteristics to be exploited in genetic combinations that are agriculturally useful, under different perspectives, such as: qualitative and quantitative productivity, resistance to parasites and unfavourable environmental conditions, the adaptability to specific edaphic situations, etc.".[33]

Moreover, applied research in mutation breeding should have been complemented by a broad pure research activity in the field of plant cytogenetics and animal biology. With regard to plant cytogenetics, D'Amato was indicated as the main responsible of a series of research projects on the genetic, biochemical and physiological effects of gamma radiation on seeds and other plant organs.[34]

In mid-March 1956, Avanzi drew Francesco Giordani's attention to the D'Amato-Scarascia project.[35] However, it is precisely in those months that Pisa's candidacy started to suffer the competition of a similar — albeit vaguer — proposal coming from the MAF's General Direction for Agricultural Production and from its network of agricultural experimental stations. The news emerged clearly from the correspondence between Avanzi and Giordani, causing some preoccupation:

> According to news from the Ministry of Agriculture and Forestry (General Direction for Agricultural Production), it appears that, while no initiative has been taken with regard to the creation of a gamma field at one of the experimental stations that depend on it, there is nevertheless a desire to do so.[36]

To fend off the MAF's attack and defend the priorities of the Pisan gamma field project, Avanzi adopted a twofold strategy. In first instance, thanks to the

[32] E. Avanzi, F. D'Amato, *Progetto di un campo gamma per ricerche di genetica applicata all'agricoltura*, 6 febbraio 1956, p. 1, in Archivio D'Amato.

[33] E. Avanzi, F. D'Amato, *Progetto di un campo gamma per ricerche di genetica applicata all'agricoltura*, 6 febbraio 1956, pp. 1-2, loc. cit. a nota 30.

[34] E. Avanzi, F. D'Amato, *Progetto di un campo gamma per ricerche di genetica applicata all'agricoltura*, 6 febbraio 1956, p. 3, loc. cit. a nota 30. Mario Benazzi, director of the Institute of zoology and comparative anatomy in Pisa, would conduct research on experimental mutations aimed at understanding the chromosomic cycle, the sex genetics and the embriogenesis of Planarias and Tritonias.

[35] Avanzi to Giordani, 9 February 1956; letter from Giordani to Avanzi, 20 February 1956, in Archivio D'Amato.

[36] Avanzi to Giordani, 1 June 1956, in Archivio D'Amato.

mediation of the CNRN and of Felice Ippolito, the university dean intensified the scientific collaboration with the USAEC's Division of biology, headed by Paul B. Pearson. In early June 1956, Pearson met Avanzi and D'Amato in Pisa in order to discuss the gamma field project and to visit the locations that were to host it:

> The day I spent at the University of Pisa with you and professor D'Amota (*sic*) was one of the most stimulating and interesting of my entire trip. (…)
> I was especially pleased to see the detailed plans Professor D' Amota (*sic*) has prepared for the gamma radiation field. I am very hopeful that this can become a reality for the University as I think it would broaden the scope of research of several of the Institutes. I was especially impressed with the extensive native forest dating back to the thirteenth century and the unusual opportunity this affords for ecological studies.[37]

Only a few days after Pearson's letter — and thanks also to Ippolito's personal interest in the matter — D'Amato obtained a USAEC grant for a four-month research visit at the Brookhaven National Laboratory.[38] If we consider not only the transfer of scientific and technological knowledge but also the international circulation of mutants that followed from this American research trip, we can safely argue that it was of seminal importance for the launch of the Italian programme on the radioinduced mutagenesis of durum wheat. It was, in fact, in Brookhaven that D'Amato had the opportunity to irradiate large numbers of "Cappelli" durum wheat seeds with x-rays and thermal neutrons, whose subsequent generations he then studied on his return to Italy: first at the University of Pisa (1956-59) and later at the Casaccia Centre for Nuclear Studies (from 1960 on).[39]

In addition to the internationalisation process that focused on the privileged relationship with the United States, Avanzi also sought to strengthen the project at a local and national level. In those same months, he thus took on the direction, in Pisa, of the Regional Institute for Cereal Agriculture, an agricultural experimental station relying on the MAF.[40] This twofold strategy — via the special relation with the USAEC (thanks to D'Amato's mediation) at the international level and, at the national level, through Avanzi's role in the MAF network — reinforced the candidacy of the Pisan project in the eyes of the CNRN, as it suggested the possibility of a potential "nationalisation" of the Pisan gamma field through a "special agreement" with the MAF's experimental stations and with other university institutes.[41]

[37] Pearson to Avanzi, 13 June 1956, in Archivio D'Amato.

[38] Ippolito to Avanzi, 8 June 1956, in Archivio D'Amato.

[39] Other than the "Cappelli", he also irradiated two other cereal varieties ("Brescia" soft wheat and "Arno" corn) and four fodder varieties. See E. Avanzi and F. D'Amato, *Programma di ricerche sul miglioramento genetico di piante agrarie con l'impiego di radiazioni ionizzanti*, 7 September 1957, in Archivio D'Amato.

[40] Avanzi to Giordani, 1 June 1956, in Archivio D'Amato.

[41] Avanzi to Giordani, 1 June 1956, loc. cit. a nota 38.

In December 1956, the CNRN — legally renewed in the summer of 1956 and rapidly growing as an organisation — promoted the establishment of ten Commissions for the study of nuclear energy applications in Italy. The Study commission for the application of radioisotopes was led by Vincenzo Caglioti, Professor of inorganic chemistry at the University of Rome, and was composed of three subcommissions: respectively biology, medicine and agriculture.

The makeup of the subcommission dedicated to agrarian sciences neatly mirrored the dichotomous division of the interests at stake. In fact, on the one hand, it hosted exponents of Buzzati-Traverso's "transnational elite", connected to the CNRN: in addition to Buzzati-Traverso, D'Amato and Scarascia, it included Elio Baldacci, plant pathologist at the University of Milan; Sergio Tonzig, botanist at the University of Milan; and Giambattista Marini Bettolo, biochemist at the Higher Health Institute. On the other hand, the subcommission included members from the more domestic network of the MAF research institutes and agricultural stations: Ugo De Cillis, director of the National Institute of Genetics and Cereal Research in Rome; Ottaviano Bottini, an agricultural chemist at the University of Bari; Mario Scapaccino, general director of the MAF's agricultural production; and the officials Francesco Curato and Innocenzo Fiori, representing the MAF and the Development Fund for the South of Italy (*Cassa per il Mezzogiorno*) respectively.

In view of a similar composition, it comes as no surprise that the subcommission's first meeting — held on 22 December 1956 — was traversed by rather evident tensions. In particular, the competition between the University of Pisa (what we could call the Avanzi-D'Amato-Scarascia group) and the MAF emerged very clearly. In fact, according to the meeting's minutes, two distinct gamma field projects were under the CNRN's consideration. The first to be proposed during the meeting was that by Ugo De Cillis: it had a predominantly national dimension, was focused on the National Institute of Genetics and Cereal Research in Rome and could count on the "substantial economic means" of the MAF and its network of experimental stations. The proposal came directly from the Ministry, as Caglioti specified during the debate.[42]

The second project was, instead, centred around the CNRN and internationally supported by the USAEC, thanks to the direct relations between D'Amato and Pearson. Just back from Brookhaven, D'Amato himself underlined — in clear contrast with De Cillis — this international dimension, also anticipating that Italy would soon be able to benefit from a radioactive Cobalt source provided by Washington:

[42] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della prima riunione, 22 dicembre 1956, p. 5, in Archivio Scarascia, b. 93.

Prof. D'Amato furthermore gives an account of the experience he acquired during his three-month stay in Brookhaven and during a trip on behalf of the CNRN to various American research centres for the application of atomic energy to plant biology. With regard to gamma fields, the position that currently prevails in the United States is that which foresees the use of not excessively powerful sources; indeed, the USAEC recently fabricated five units of gamma radiation, complete with a container and mechanisms to move the source, equipped with a 200-curie radioactive Cobalt source. According to news provided by Prof. D'Amato and by Dr. Pearson, head of the USAEC's Biology Branch who has already examined the project of the University of Pisa, it is expected that one of the aforementioned facilities may be adopted in Italy.[43]

Throughout the discussion, Adriano Buzzati-Traverso insisted that he was strongly in favour of the Pisan gamma field project, stressing the necessity to include Italy in an international research context and advocating the organisation of training courses for the application of radioisotopes in biology and agriculture; these could help amend the "nearly total absence in Italy of young experts in plant genetics".[44]

In the presence of two contrasting gamma field projects, the subcommission closed its first meeting with a diplomatic proposal: on the one hand, President Caglioti was to organise a summit meeting between the Minister of agriculture (the Christian Democrat Emilio Colombo), the president of the CNRN (Senator Basilio Focaccia) and the dean of the University of Pisa, Enrico Avanzi, to settle the matter of the gamma field site.[45] On the other hand, Buzzati-Traverso, D'Amato, Scarascia and De Cillis were entrusted with the task of preparing a research programme that would carefully consider "the international context in terms of facilities and scientific achievements".[46]

The subcommission's second meeting took place on 26 March 1957. The previous day, Avanzi had sent a letter to Caglioti where he claimed Pisa's primacy in the elaboration of the gamma field project. This was both a chronological and a scientific primacy: the project dated back to September 1955 and the local Faculty of Agrarian sciences was highly esteemed. It is no coincidence that, in his letter, Avanzi stressed Pisa's existing relations with the MAF as much as with the USAEC:

I must add that Pisa even hosts the headquarters of the Regional Institute of Cereal Agriculture, which functions as a joint experimental station and depends on the Ministry of Agriculture and Forestry.

[43] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della prima riunione, 22 dicembre 1956, p. 5, loc. cit. a nota 40.

[44] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della prima riunione, 22 dicembre 1956, p. 7, loc. cit. a nota 40.

[45] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della prima riunione, 22 dicembre 1956, p. 5, loc. cit. a nota 40.

[46] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della prima riunione, 22 dicembre 1956, p. 7, loc. cit. a nota 40.

Either way, let me point out that genetic and agronomic research is being conducted at the above-mentioned institutes, on agricultural plants taken from seeds that have been subjected to different radiations at the American laboratory of Brookhaven.[47]

During the meeting of 26 March, Caglioti presented the content of Avanzi's letter in an attempt to mediate between the two opposed gamma field projects. On one side, the Commission's president for the application of the radioisotopes — evoking the examples of Frascati's synchroton and Ispra's reactor — stressed "the opportunity to concentrate the research units in a few locations", and highlighted the fact that many research institutes were connected to the MAF, "around which and in collaboration with which the new Research centre could arise". On the other, Caglioti confirmed the immediate availability of a 200-curie radioactive Cobalt source that the USAEC was ready to donate to Italy, announcing the intention to entrust the scientific management of the gamma field — wherever it would arise — to Francesco D'Amato, "an internationally renowned and highly esteemed scholar".[48]

In spite of the mediation efforts, the subsequent debate among members of the subcommission formalised the lack of agreement. D'Amato stressed the importance of locating the gamma field in Pisa, "where we could benefit from a possible location near the city, and where research in the field of radiation applications for the study of genetics is already on the way".[49] Conversely, Scapaccino and De Cillis said being in favour of the establishment of a gamma field "in the surroundings of Rome" and certainly within the MAF's network of institutes and stations of agrarian experimentation.[50] Those who supported, instead, the Pisan option — albeit in a rather diplomatic manner — were Buzzati-Traverso, who explained his position mainly through his concern that "the best possible conditions for efficiency and management" be created, and Bottini, who hoped that the future Centre would be guaranteed "highly qualified staff".[51] At the end of the discussion, a partial compromise was nevertheless obtained: in the absence of objections, the Commission accepted the decision to entrust the scientific management of the future Centre to D'Amato, while the issue concerning "the gamma field and its potential insertion in a wider complex, dedicated to research on the application of radioisotopes in agriculture, would once more be postponed

[47] Avanzi to Caglioti, 25 March 1957, in Archivio D'Amato.

[48] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della seconda seduta, 26 marzo 1957, pp. 2-3, in Archivio Scarascia, b. 93.

[49] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della seconda seduta, 26 marzo 1957, p. 3, loc. cit. a nota 46.

[50] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della seconda seduta, 26 marzo 1957, pp. 3-4, loc. cit. a nota 46.

[51] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della seconda seduta, 26 marzo 1957, p. 4, loc. cit. a nota 46.

to the joint political decision of the Minister of Agriculture and the CNRN's president".[52]

In subsequent months, between March and October 1957, the Avanzi-D'Amato-Scarascia project gradually gained ground (with the support of Buzzati-Traverso), pursuing with even more vigour that strategy of internationalisation and "Americanisation" that had been launched in the spring-summer of 1956.

The first stage of this process was Buzzati-Traverso's intense American tour across the USAEC's laboratories in June 1957: the USAEC's Division of Biology and Medicine in Washington; the Biology Division at Oak Ridge, run by Alexander Hollaender; the two laboratories — Brookhaven National Laboratory in Long Island and the Blandy Experimental Farm at the University of Virginia — linked to the research activities of the geneticist Ralph W. Singleton; and finally, the Division of Biology and Medical Research at Argonne National Laboratory.

At the end of the tour, in a letter-report sent to Caglioti from La Jolla (California), Buzzati-Traverso outlined what should have been the CNRN's future Division of Biology, structured on the basis of the American model.[53] Following the example of Brookhaven, Buzzati's project anticipated the creation of two biology laboratories of the CNRN: a main one at Frascati's synchroton, and a minor one at Ispra's reactor.[54] Other than the laboratories, and again with the USAEC's support, in Buzzati's view the CNRN would have had to finance the organisation of a training programme in genetics and radiobiology for young researchers and foster research conducted at university level in this sector:

> Independently from the activities that may be conducted at the two laboratories of the DB, it will be useful to keep aside sufficient funds for research at university institutes. This will enable a growing interest of the academic world in problems related to radiobiology. The current Italian conditions are extremely embarrassing, as only very few people have previously worked in the field of radiation biology.[55]

In relation also to the future structure of the gamma field, Buzzati's tour across the USAEC's laboratories — and especially his personal relations with Pearson and Singleton — allowed him to obtain detailed information on the costs, architectural modalities and safety risks. Other than the Cobalt-60 source and the mechanism behind its functioning, a new model of gamma field, borrowed

[52] Cnrn. Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie). Verbale della seconda seduta, 26 marzo 1957, p. 4, loc. cit. a nota 46.

[53] Buzzati-Traverso to Caglioti, 9 June 1957, p. 1, in Archivio Edoardo Amaldi (Università di Roma La Sapienza, Dipartimento di Fisica), sc. 198, fasc. 1, sfasc. 2 "Divisione Biologica (Documenti e corrispondenza)".

[54] Buzzati-Traverso to Caglioti, 9 June 1957, p. 2, loc. cit. a nota 51.

[55] Buzzati-Traverso to Caglioti, 9 June 1957, p. 3, loc. cit. a nota 51.

from Singleton's laboratory project in Brandy (Virginia), was also arriving from the United States. Singleton's Brandy model was a source of inspiration for CNRN's nuclear ambitions. Conceived as a circular depression protected by a surrounding hill, it was, in fact, not only a cheaper solution, but also a less invasive one from the point of view of territorial expansion:

> With regard to the most convenient arrangement of the source, I have received very interesting information from Prof. Singleton, who has set up the first gamma field in Brookhaven and is now preparing another one, with an identical source as the one intended for Italy, at the agricultural experimental station of the University of Virginia. Singleton claims that it is too risky to place this source in the full field, even in case of a wide buffer zone. In view of these considerations, Singleton is installing the Cobalt source in a kind of circular depression, with a diameter of about nine metres wide and protected all round by a small circular hill, obtained by digging up earth. He believes that the available space is entirely sufficient for the radiation of a large number of plants or seeds. Given the strong population density of our country and the low level of prevailing crop, it seems to me that Italy, too, needs to consider installing a gamma radiation source like that of Singleton. This would also have the benefit of considerably bringing down the cost of the structure as we wouldn't need to reserve a large plot of land for this purpose. On my return to Italy I will bring along details of the Brandy plant in Virginia.[56]

In addition to Buzzati-Traverso's "American pilgrimage" (to use his own words), the second decisive initiative at this stage for the internationalisation of the gamma field project was Scarascia's participation — between March and June 1957 — in the OEEC-EPA Mission 396, dedicated to "Atomic Energy in Agriculture". In parallel to the establishment of the European Atomic Energy Community (EURATOM) in March 1957, through this initiative the *European Productivity Agency* (EPA) — an integral part of the Organisation for European Economic Co-operation (OEEC) — promoted a transatlantic exchange of managerial and scientific-technological knowledge of nuclear energy applications in agriculture.[57]

From August 1956 onwards, the CNRN and the University of Pisa vigorously supported Scarascia's nomination as a member of the Italian delegation, thus opposing the resistance of the Experimental Tobacco Institute of Rome, where Scarascia was employed. Although the dispute was apparently motivated by budget problems (namely the need to cover Scarascia's travel expenses in the United States), it more likely reflected the already outlined tensions between institutions and disciplinary fields. On 9 August, Avanzi himself indicated Scarascia's name to the National Productivity Agency. The young researcher did not hesitate to express his gratitude:

> I wish to (…) thank you from the bottom of my heart for having proposed my name to the Italian Productivity Agency for a research visit to the US. My Institute has received a similar

[56] Buzzati-Traverso to Caglioti, 9 June 1957, pp. 2-3, loc. cit. a nota 51.

[57] Bent Boel, *The European Productivity Agency and transatlantic relations, 1953-1961*, Copenhagen, Museum Tusculanum Press, 2003.

request but, without my knowledge, they replied mentioning budget problems and time issues that would make my participation impossible. I hope, supported by Your nomination, to be able to overcome such resistance.[58]

In the same period, the CNRN approached the Tobacco Institute, offering its availability to fully bear the travel expenses. In a "personal and reserved" letter, Scarascia's brother — the Christian Democrat MP Carlo Scarascia — solicited Carlo Russo (undersecretary of the Presidency of the Italian Council) to intercede in the National Productivity Agency and convince the latter to cover his brother's travel expenses to the United States:

You have already realised the importance this experience in the American laboratories could have for everyone, so I am certain that you will do whatever is necessary to avoid, as I told you in person, that the lack of funds becomes *no more than an excuse to conceal other matters*.[59]

In the end, 21 researchers from nine European countries joined the EPA Mission 396.[60] For Italy, Alberto Malquori — Professor of forestry and agricultural chemistry at the University of Florence — participated in addition to Scarascia. The goal of the mission was to enhance the exchange of knowledge between the United States and Western Europe in relation to the applications of atomic energy in the fields of agriculture, zootechnics and food conservation. The programme of planned visits — what Scarascia defined, not by chance, a true "interplanetary journey" — foresaw a packed tour (from 28 March to 29 June 1957),[61] which included lectures, observations and demonstrations at the most relevant American research centres in the fields of radiation biology and mutation breeding: the National Agricultural Research Center of Beltsville, in Maryland, and the local University of Maryland, College Park; the Oklahoma Agricultural and Mechanical College; the Isotope Program of Kansas State College; the Iowa State College of Agriculture and Mechanic Arts; the Quartermaster Food and Container Institute of Chicago; the

[58] Scarascia to Avanzi, 26 August 1956, in Archivio D'Amato.

[59] Carlo Scarascia Mugnozza to Russo, n.d. [in reality in August 1956], in Archivio Scarascia, b. 94; italics mine.

[60] A Dutchman (Adriaan Cornelis Schuffelen), four Portuguese (Luis Rodriguez Balbino, Reinaldo Rodrigues, Antonio Leto, Jose de Almeida Alves), four Danes (Paul Erik Jacobsen, Erik Stendberg Knudsen, Carl Goran Lamm, Victor Middelboe), four Germans (Karl-Heinz Menke, Manfred Wilhelm Mussgay, Walter Partmann, Bernhard Ulrich), three Greeks (Theocazis Metakides, Catherine Papadopoulou, Athanassios Hatizkakidis), one Belgian (Arthur Riga), one Swiss (Alfred F. Schurch) and an Icelander (Bjorn Sigurbjornsson).

[61] Riga to Scarascia, 30 July 1957, in Archivio Scarascia, b. 94; in his letter, Riga attributes the expression to Scarascia. On the centrality of travel in the circulation of scientific-technological knowledge during the Cold War, see J. Krige (ed.), *How knowledge moves: writing the transnational history of science and technology*, Chicago and London, The University of Chicago Press, 2019.

Colleges of Agriculture at the University of Wisconsin and at Michigan State University; the University of Michigan in Ann Arbor; the MIT's Department of Food Technology in Cambridge (Massachusetts); the Brookhaven National Laboratory; the New York State College of Agriculture at Cornell University; the Oak Ridge Institute in Tennessee; the United States Department of Agriculture in Washington DC.[62]

In their concluding report, which was published in *La Ricerca scientifica* (the organ of the Italian National Research Council, CNR), Scarascia and Malquori accurately described the radioisotopic applications in the soil and fertilisation sector, in the field of growth and herbicide regulators, in food conservation, and in research on plant genetics, zootechnics and microbiology. After illustrating how the USAEC's research was organised, Scarascia and Malquori's report summarised the measures to be adopted for the development, in Italy, of "agricultural research with the use of radioisotopes or ionising radiations". Three elements, in particular, were stressed: first, the need for government support for public and private projects aimed at the application of atomic energy in agriculture; second, the urgency to provide training for scientific staff with the help of all resources made available by the USAEC, the EURATOM, the OECE-EPA and the UNESCO; finally, the importance of keeping together applied and pure research, and of setting up cross-cutting and interdisciplinary research groups.[63]

At the start of September, D'Amato and Scarascia drew the attention of the CNRN's subcommission for agrarian sciences to a project aimed at "exploiting for the purpose of genetics and biology research the nuclear facilities soon to be constructed in Italy".[64] D'Amato and Scarascia, ever more confident after the "experience gained during their recent training trips in the United States of America" and probably expecting a long timeframe for the establishment of the gamma field,[65] requested that specific structures be installed close to the CP5 reactor that was being built at Ispra, for the purpose of plant genetics research. In particular, they requested a thermal pillar for the exposure of biological material (i.e. seeds, root cuttings, cultures of microorganisms, spores) to thermal and fast neutron fluxes, and a supervised greenhouse placed at the end of one of the reactor's canals, for acute or chronic exposures to the neutron flux

[62] International Cooperation Administration in collaboration with U.S. Department of Agriculture and Land-Grant Colleges, Program and Itinerary, for PI0-60036-OEEC-EPA "Atomic Energy in Agriculture", 4 agosto 1957, in Archivio Scarascia, b. 94.

[63] Alberto Malquori, Gian Tommaso Scarascia, *Le applicazioni delle scienze nucleari in agricoltura e alimentazione negli Stati Uniti*, "La ricerca scientifica", marzo 1959, a. 29, n. 3, p. 464.

[64] *Proposta per uno sfruttamento a fini di ricerca genetica e biologica delle attrezzature nucleari di prossima realizzazione in Italia, presentata da G.T. Scarascia e F. D'Amato alla Commissione "Applicazione dei Radioisotopi (Scienze Agrarie)" del CNRN*, 2 settembre 1957, in Archivio Scarascia, b. 93.

[65] *Proposta per uno sfruttamento a fini di ricerca genetica e biologica delle attrezzature nucleari di prossima realizzazione in Italia*, loc. cit. a nota 62.

of larger-sized organisms. Moreover, with an eye to the future D'Amato and Scarascia suggested that accelerators of particles be created, to be used as the source of particularly pure, fast neutron fluxes.[66]

Avanzi and D'Amato made a further funding request to the CNRN on behalf of the University of Pisa, for a three-year research project aimed, on one side, at continuing the genetic screening and cytogenetic analysis of the mutants of the nine species D'Amato and Scarascia had radiated in previous years, in Sweden, the United States and the United Kingdom; on the other, the project sought to further radiate "Cappelli" durum wheat seeds and "Brescia" soft wheat so as to obtain, "through mutagenesis, some further, good agricultural characteristics".[67] Other than Avanzi and D'Amato, the research group was composed — for the genetics side — of Scarascia, Silvana Avanzi (a MAF research fellow for cytogenetics) and Alessandro Bozzini (one of D'Amato's recent graduates in agrarian sciences at the Collegio Antonio Pacinotti of Pisa), and on the agricultural side of Ranieri Favilli (full professor of agronomy at the University of Pisa), Enrico Moschini (university lecturer and research assistant at the Institute of agronomy) and Vittoria Nuti-Ronchi (MAF research fellow for agronomy).[68]

On 7 October 1957, the final meeting of the Commission for the study of radioisotope applications was held in a joint session of the two subcommissions dedicated to agriculture and biology. From a geographical perspective, it was by now evident that the negotiations between the CNRN and the MAF tended towards the positioning of the gamma field not in Pisa but "in the proximity of Rome".[69] The possibility — developed in the summer of 1957 — of using an area located seven kilometres from Pisa (in the town of "Bufalotti"), which was linked to the future installation of an experimental swimming pool reactor by the Centre for military nuclear energy applications (CAMEN), was thus suspended. Yet, the victory — on a scientific level — of the "Pisan" line represented by Avanzi-D'Amato-Scarascia was overwhelming:

[66] *Proposta per uno sfruttamento a fini di ricerca genetica e biologica delle attrezzature nucleari di prossima realizzazione in Italia*, loc. cit. a nota 62.

[67] Enrico Avanzi and Francesco D'Amato, *Programma di ricerche sul miglioramento genetico di piante agrarie con l'impiego di radiazioni ionizzanti*, 7 settembre 1957, pp. 5-6, in Archivio D'Amato. The project was sent to the CNRN on 12 September.

[68] E. Avanzi, F. D'Amato, *Programma di ricerche sul miglioramento genetico di piante agrarie con l'impiego di radiazioni ionizzanti*, 7 settembre 1957, p. 4, loc. cit. a nota 65.

[69] Ippolito to Franzini (CAMEN, Livorno), 24 October 1957, in Archivio D'Amato. Ippolito replied to Franzini's proposal to host the gamma field near the future location of the CAMEN experimental reactor, decided on the basis of an agreement between the Ministry of Defence and the University of Pisa: "The proposal — Ippolito wrote — is nevertheless very interesting for this Committee. Regrettably we aren't currently able to give a definitive reply due to the ongoing negotiations with the Minister of Agriculture, the Honourable Dr. E. Colombo, as to the granting of a plot of land in the proximity of Rome for the creation of the Campo Gamma". The discussions concerning this issue between Avanzi, dean of the University of Pisa, and Franzini, scientific director of the CAMEN, date back to July 1957: Avanzi to Franzini, 27 July 1957 and 20 August 1957; Franzini to Avanzi, 5 August 1957; Franzini to Buzzati-Traverso and Avanzi, 21 October 1957, in Archivio D'Amato.

D'Amato would obtain the future scientific management of the gamma field; the Avanzi-D'Amato research project was approved; the scientific management of the CNRN's newborn Biology service (the future Biology Division) went to Buzzati-Traverso; Scarascia was nominated secretary of the agricultural sciences section.[70] Finally, Åke Gustafsson — a long-time friend and collaborator of D'Amato, as we have seen — was indicated as an external advisor to the CNRN Biology Division in the field of atomic energy application to agriculture.[71] Francesco D'Amato closed the circle when he obtained, in 1959, the chair in genetics in the Faculty of Agrarian sciences at the University of Pisa, the first one in the Italian university system. When, a few years later, Carlo Jucci died (in 1963),[72] D'Amato would take on the direction of the Italian Society of Plant Genetics, actually relaunching it by changing its statute and goals.

To conclude, the Cold War political context, the launch of a national and international programme for nuclear energy application to agriculture and the development of a scientific, transnational network focused on mutation breeding turned out to be decisive not just in giving research on radioinduced mutagenesis in Italy a new stimulus, but also in defining the scientific and disciplinary boundaries of plant genetics, promoting its institutionalisation at the academic level.

The gamma field as reality and as sociotechnical imaginary

In May 1958, the CNRN's journal announced that the future gamma field would be built on land offered by the Ministry of agriculture in Monterotondo, in the town of Tor Mancina, in the area of the Zootechnical Experimental Station in Rome.[73] The Casaccia area was probably spotted towards the end of the year. In his autobiographical reconstruction, Scarascia dates the decision moment at the end of October 1958:

[70] Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie e scienze biologiche), verbale della riunione comune, 7 ottobre 1957, pp. 2-4, in Archivio Scarascia, b. 93.

[71] Commissione di studio per l'applicazione dei radioisotopi (Scienze agrarie e scienze biologiche), verbale della riunione comune, 7 ottobre 1957, all. n. 1, *Elenco di consulenti stranieri per lo sviluppo delle attività di ricerca del Servizio di biologia del CNRN*, loc. cit. a nota 68.

[72] Importantly, since April 1958 Jucci directed the radiobiology-genetics section of the Institute of Nuclear Studies for Agriculture, which was chaired by the Christian Democrat MP Achille Marazza. The Institute had been established to "promote research on the application of atomic radiations and radium elements in the agricultural and zoological field" as also to "establish an information centre for nuclear research on a specifically practical level, in such a way as to progressively include the research results in the enhancement plans of agricultural firms and zootechnical firms" (art. 3 dello Statuto, "Agricoltura d'Italia, Organo ufficiale dell'Istituto di studi nucleari per l'agricoltura", aprile 1958, p. 10). Alberto Pirovano was the director of the electrogenetics section of the Institute. See Jucci's obituary in "Il Corriere di Roma": Giuseppe A. Diffidenti, *Ha commosso la scienza la morte di Carlo Jucci. Un grave lutto per l'Istituto di studi nucleari per l'agricoltura*, "Il Corriere di Roma", 4 novembre 1962, p. 8.

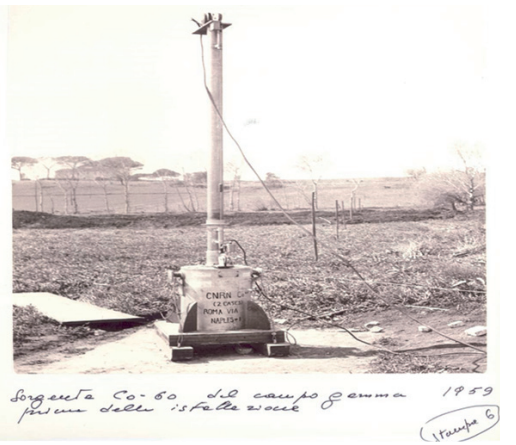
[73] G.T.S. (Gian Tommaso Scarascia), *Nota*, "Notiziario Cnrn", maggio 1958, a. IV, n. 5, p. 271.

At the end of October 1958 we made a last inspection: I remember Adriano Buzzati Traverso was there, Umberto Belliazzi, myself, representatives of the Milanese study that was supposed to develop the centre's urban project. The area was adequate, also because the hilly elevations, the isolated position and the presence of a small watercourse in themselves already guaranteed some degree of safety, even from a gamma field perspective. Oddly, this choice was encouraged by the fact that Buzzati Traverso found a lucky clover precisely on the small hill where the reactor would have arisen; we conserved it for a long time in a small frame in the office of the then Division of biology in Rome.[74]

In December 1958, the CNRN's journal mentioned, for the first time, the "Bracciano zone at 23 km from Rome between the via Anguillarese and the via Claudia".[75] The name "Casaccia" referred to a modest farm whose lands had belonged to the Chigi family ever since the seventeenth century.

In April 1959, at km 1,3 of the Anguillarese country road, works began for the construction of the Centre for Nuclear Studies; it was meant to gather, in a single location, some of the laboratories and research groups that CNRN had previously funded by academic sources. The Laboratory for Agricultural Applications (subsequently Laboratory of Plant Genetics) — with the attached gamma field — was inaugurated in January 1960,[76] even if some preliminary activities had been conducted as of July 1959.[77] Scarascia was nominated Laboratory director, whereas D'Amato acted as scientific advisor.

Fig. 3 — Luigi Rossi private archive, bird's-eye view of the gamma field, 1960



[74] *A colloquio con G. Scarascia Mugnozza*, in G. Paoloni (ed.), *Energia, ambiente, innovazione: dal Cnrn all'Enea*, p. 185.

[75] *Attività del Comitato*, "Notiziario Cnrn", dicembre 1958, a. IV, n. 12, p. 863.

[76] G.T.S. (Gian Tommaso Scarascia), *Nota*, "Notiziario Cnrn", gennaio 1960, a. VI, n. 1, pp. 4-9.

[77] *Il Centro di Studi Nucleari della Casaccia*, Rome, CNEN, 1962, p. 6.

Fig. 4 — Luigi Rossi private archive, presentation of the planimetry of the Casaccia Nuclear research centre (no date)

Loaded in Brookhaven in May 1958, the radioactive Cobalt-60 source was stored for over two years in a storage room of the Termini railway station in Rome. The correspondence between D'Amato and Pearson — who had, in the meantime, moved from the USAEC to the Ford Foundation — gives us an impression of the concerns that accompanied the long negotiations (from 1955 to 1960) for the construction of the Italian gamma field and the subsequent identification of its location, first in Pisa and then in Rome:

I am glad to know that you are continuing your activities with the CNRN and that you share the major responsibility for developing the genetics programme at Casaccia. With your leadership I am sure that the gamma field will be actively used. I realize of course that this facility has some limitations. As you know, I was most concerned that it took more than three years to cut through the red tape so that the gamma field could finally be shipped to Pisa. Even so, I take some satisfaction in knowing that this has finally been accomplished.[78]

Between 1960 and 1963, the Casaccia Centre for Nuclear Studies inaugurated other laboratories: the laboratories of the Division of Biology and Health Protection;[79] the Applied Nuclear Physics Laboratory, linked to the

[78] Pearson to D'Amato, 25 February 1960, in Archivio D'Amato,

[79] The Division of biology and health protection occupied five buildings, which hosted: the Laboratory of Agricultural Applications; the Laboratory of animal radiobiology; the Laboratory of dosimetry, standardisation and applied nuclear instrumentation; the Laboratory for environmental radioactivity; the Applied meteorology section; the Laboratory for sanitary engineering; the Sanitary physics section; and the Medicine and health section. See: *Il Centro di Studi Nucleari della Casaccia*, pp. 41-50.

RC-1 (Triga Mark II type) reactor that the General Atomic had obtained in 1958; the Reactor Engineering and Servomechanisms Laboratory; the Physics and Reactor Calculus Laboratory, linked to two other nuclear reactors; the Electronics Laboratory; the laboratories of the Division of materials (industrial chemistry, metallurgy, ceramic technology and hot operation) and those of the Geology-Mining Division.[80]

Fig. 5 — Luigi Rossi private archive, reproduction of the gamma field at the EUR, during the Sixth International Electronics and Nuclear Congress (1959)

South of the gamma field, four hectares of experimental fields were used for the breeding, selection and multiplication of materials treated with physical and chemical mutagenesis and of their progeny. The fields were also used for the multiplication of genetically homogeneous lines of species to be used in radio-biological research. To the north, instead, a group of greenhouses (covering some five hundred square metres) was used for experiments in conditions that were monitored for temperature, humidity and lighting.

In the temporal limbo that lasted from the start of the construction works for the Casaccia Centre for Nuclear Studies — at the end of 1958 — to the launch of an actual research programme in the field of mutation breeding, in the early 1960s, the CNRN organised an impressive communication campaign, which served to legitimise the use of nuclear energy in agriculture through the symbolic transformation of the gamma field into an iconic and laical place of modernity, progress and peace. At that time, this rhetoric had wide

[80] *Attività del Comitato*, "Notiziario Cnrn", giugno 1960, a. VI, n. 6, pp. 531-541.

transnational resonance, and it was frequently adopted by the USAEC, the FAO, the EURATOM and, subsequently, by the International Atomic Energy Agency. In the Italian context, however, it assumed an additional meaning: on the one hand, it evoked the specific dynamics of the ongoing economic boom by depicting the "charm of the atom" as an important step in the process of innovation and industrialisation of Italian agriculture; on the other hand, the very reference to agriculture and, in particular, to durum wheat — hence, to pasta — contributed to popularise the image of the "practical" atom waiting to satisfy the Italians' new food necessities.[81]

In this sociotechnical imaginary, attuned to the romantic notes of the "atomic sublime",[82] the gamma field became — in first instance — synonymous with unstoppable modernity: a derelict farm turned atomic laboratory hosting a group of young researchers in their 30s, who stood out because of their informal, American-like style, with no ties and "their shirts hanging over their rolled-up trousers".[83] In August 1959, while the construction site in via Anguillarese was still open, Turin's daily "La Stampa" sketched the pastoral landscape of a cowshed ready to host a nuclear amphitheatre:

> The "Gamma field" is located at the Casaccia, some twenty kilometres from Rome, among the tufts of pine trees in via Anguillarese. Basic offices arise across 65 hectares of hilly terrain, located in the rooms where the herdsman's family once lived, as well as a tower where labourers — working even at night, illuminated by a spotlight — are constructing the new nuclear reactor, which is to start working by October. Just behind the old barns, the "Gamma field" spreads out, circumscribed by a 4 metre-high wall, so as to contain the radiations of the Cobalt source, nowadays still lying quietly in its lead cylinder.[84]

Only a few years later, in October 1962, the mutation was completed. The daily "l'Unità" — the organ of the Italian Communist Party — narrated the evocative story of a site that had radically changed from a farm to a nuclear laboratory, from an agricultural firm to an atomic garden:

> For some years now, in the meadows along the road that leads to Anguillara — on the Bracciano lake — you no longer see the cows and calfs of the La Casaccia farm, the ancient property of a family of papal aristocracy. The farm's central building still exists and hasn't been changed from the outside, but surrounding it, instead of the stables and the barns, modern concrete and glass buildings rise up, a very high chimney, and on one side an earth-

[81] For a comparative analysis of the imaginary of the "peaceful atom" in Italy, France and United States, see: Laura Ciglioni, *Culture atomiche. Gli Stati Uniti, la Francia e l'Italia di fronte alla questione nucleare (1962-68)*, Rome, Carocci, 2020, pp. 283-89; 352-54.

[82] Peter B. Hales, *The atomic sublime*, "American Studies", 1991, vol. 32, n. 1, pp. 5-31; David E. Nye, *American technological sublime*, Cambridge (MA) and London, The MIT Press, 1994, pp. 234-35.

[83] Enrico Altavilla, *Le radiazioni d'una centrale di cobalto potranno modificare le specie vegetali*, "La Stampa", 4 agosto 1959, p. 7.

[84] E. Altavilla, *Le radiazioni d'una centrale di cobalto potranno modificare le specie vegetali*.

work with a kind of low pillbox. You can also see trees, bushes, little plants but of very diverse species, like in a normal garden, not in an agricultural firm.
In fact, the Casaccia is no longer a farm, but for two and a half years now it hosts a Nuclear research centre whose main characteristic — namely that which establishes a new relation between technical-scientific progress and nature — is the "Gamma field" (…).[85]

The control of nature through the management and acceleration of the evolutionary process was the distinctive mark of this modernity. Again, Enrico Altavilla — in an article published in "La Stampa" in the summer of 1959 — described the gamma field as a

mysterious open-air laboratory where young alchemists, with the help of a Cobalt source that acts as a philosopher's stone, are getting ready to violate nature by forcing it to become perfect, to make the kind of progress it was unable to make over thousands of years in only few years time, to generate flowers with new forms and unimagined colours, plants that are more resistant to diseases, grasses capable of better exploiting fertilisers, early peas, more solid firs, more oily peanuts.[86]

Although they were conscious of the principle *Natura non facit saltus*, "the young Fausts" of the Casaccia — the article continued — were nevertheless getting prepared, "with the crude determination that is typical of scientists, to produce abnormal plants, small dwarf trees that would delight Japanese gardeners and gigantic shrubs even more peculiar than the Soviet two-headed dog". Next to the "plant monsters", though, for once nature would have said "yes to the scientists": "Ceres and Pomona will agree to show more zeal, to give us better plants and fruits".[87] An aura of youthful, Promethean enthusiasm accompanied the description of the Casaccia researchers, starting from Scarascia: "They stand out because of their very young age — almost all are in their early thirties — and their relaxed dress code, shirts hanging over their rolled-up trousers as when they were practicing in the American atomic laboratories". In response to the journalist's concluding question, Goethically hinting at the possibility that nature might rebel against whoever would have attempted to "exert violence on her", Scarascia shook his shoulders and smiled. "The sorcerer's apprentices — the journalist remarked — do not fear the old lady".[88]

In the same period, in a number of radio interviews — respectively with Antonello Marescalchi for RAI's third radio programme, in May 1959,[89] and

[85] f.p., *Grano "gamma" alla Casaccia*, "l'Unità", 23 ottobre 1962, p. 6.
[86] E. Altavilla, *Le radiazioni d'una centrale di cobalto potranno modificare le specie vegetali*.
[87] E. Altavilla, *Le radiazioni d'una centrale di cobalto potranno modificare le specie vegetali*.
[88] E. Altavilla, *Le radiazioni d'una centrale di cobalto potranno modificare le specie vegetali*.
[89] *Intervista con Rai III programma (Dr. A. Marescalchi)*, 30 maggio 1959, in Archivio Scarascia, b. 95.

with Anna Keel for Radio Zurich — Scarascia himself reassured the audience, providing details on the safety of the gamma field and explaining the important — theoretical as economic — reasons behind the use of nuclear energy for the transformation of agricultural plants:

– What kind of results do you expect to obtain from the Gamma field experiments?
The field is intended for research on plant radiobiology and genetic improvement of agricultural plants; much of our work is aimed at this objective. It would be of particular interest for Italian agriculture to improve cereals, especially durum wheats, fodder and fruit plants, flowers and vegetable plants, flax flowers.
The types of radiations that will be adopted for this purpose include: gamma radiation, x-rays, and fast and slow neutron fluxes produced by the reactor that will start working in the same Research centre in the next autumn.[90]

To give a measure of the applicative potentials of mutation breeding in agriculture, he once again made reference to the successes obtained in Sweden and the United States:

– How many generations will it take to establish whether changes in a plant reflect an advantageous mutation?
I'll give you an example: in 1946, Gustafsson — a Swedish pioneer in our field — radiated seeds of the Bonus barley variety; its descendants were subjected to rigorous exams and comparative tests, and it wasn't until 1958 that one of the mutants was acknowledged as being, in fact, equipped with better traits than the original types, especially with regard to lodging resistance and greater response to nitrogen fertilisation. It was given the name of Pallas. Moreover, in Sweden they have varieties of peas, rapeseed, mustard seeds with better characteristics than the original types. In America they have obtained improvements in oats, peanuts and beans.[91]

No less important were the possibilities offered by the only TV channel: other than the dissemination of films by the USIS and the USAEC, such as *I piccoli giganti. L'agricoltura dell'era atomica* (1959) or *La magia dell'atomo* (1962-1964),[92] there were also original documentaries — for example, *Atomo pratico* and *Italia nucleare*, both directed by Giordano Repossi — that were made in collaboration with the CNRN and the Casaccia scientific staff.[93]

In addition to its communication campaign, the CNRN also made efforts to transform the gamma field into an exhibit artefact — a three-dimensional icon

[90] *Conversazione Prof. Scarascia - Anna Keel (Radio Zurigo, Svizzera)*, 18 giugno 1959, p. 3, in Archivio Scarascia, b. 95.

[91] *Conversazione Prof. Scarascia - Anna Keel (Radio Zurigo, Svizzera)*, 18 giugno 1959, pp. 3-4, loc. cit. a nota 85.

[92] *I piccoli giganti n. 4, L'agricoltura dell'era atomica*, 31 ottobre 1959, in Teche RAI, identificate teca C38; *La magia dell'atomo. Il contadino dell'era atomica*, 27 aprile 1962, in Teche RAI, identificatore teca C1668; *La magia dell'atomo. La serra atomica*, 10 marzo 1964, in Teche RAI, identificatore teca C4525.

[93] The episodes dedicated to the Casaccia Centre are, in particular, that of 24 January 1961 of *Italia nucleare* (Teche RAI, identificatore teca C669), and that of 10 March 1964 of *Atomo pratico*, titled *Il contadino dell'era atomica* (Teche RAI, identificatore teca C4525).

of peaceful nuclear energy applications to be promoted on various exhibition occasions. The first public appearance occurred in June-July 1959, during the Sixth International Electronic and Nuclear Exhibition in Rome, at the EUR's Congress palace. The CNRN prepared a miniature model of the gamma field in the pavilion of the MAF, which visually summarised the essential parts of the structure: the radiation unit, the protective earthwork, the control cabin, and the safety and control systems.[94]

Fig. 6 — Interactive miniature model of the gamma field at the CNRN's pavilion at the Trade Fair of Milan in 1959: see Fiera di Milano 1960*, April 1960, p. 157*

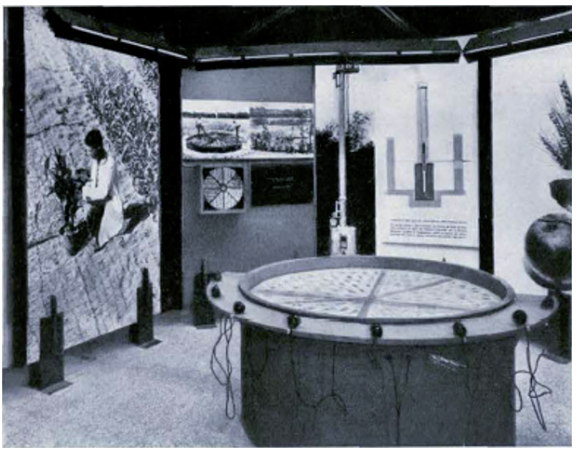
Still in 1959, the Milan Trade Fair inaugurated a new sector, significantly called Salon of Nuclear Energy Applications (hereafter SNEA). The SNEA hosted no less than 50 exhibitors from nine countries (other than Italy these included the United States, Canada, the United Kingdom, France, the German Federal Republic, Belgium, Sweden and Switzerland), on a surface of 6200 square metres, 4000 of which indoor.[95] In April 1959 and in the next year, during the Milan Trade Fair's 37th and 38th editions, again a scale model of the gamma field was presented, with attached a "small farming field" where

[94] *Notizie Italiane*, "Notiziario Cnrn", luglio 1959, a. V, n. 7, p. 469.

[95] *Barometro della congiuntura economica: il mercato campionario milanese*, "Fiera di Milano", aprile 1959, a. XI, p. 9.

the visitors could directly observe — next to the miniature wheat plants that hadn't been irradiated — some examples of radioinduced mutants.[96]

Fig. 7 — Drawing of the radiation unit adopted in the gamma field. G.T. Scarascia Mugnozza, L'energia nucleare al servizio dell'agricoltura*, Bologna, Cappelli, 1963, p. 27 (original sketch)*



The same scale model was exhibited again at the EUR, on the occasion of the Seventh International Electronic and Nuclear Exhibition, held from 15 to 29 June 1960. In the CNRN's journal, a photograph showed Edoardo Amaldi, vice president of the CNEN, as he was about to show the model to the President of the Republic, Giovanni Gronchi.[97]

Hence, even before coming into operation, the gamma field had already become an icon: the symbol of a modernity made of "peaceful atoms" and "atomic farmers".

Conclusion

From the end of the 1960s to the first half of the 1970s, the Casaccia Laboratory of Plant Genetics released new cultivars of durum wheat, which

[96] Gaetano Mannino Patané, *Possibilità presenti e future delle applicazioni dell'energia nucleare*, "Fiera di Milano", aprile 1960, a. XII, pp. 149-158; G. Mannino Patané, *Sbalorditive le pratiche applicazioni consentite dall'energia nucleare*, "Fiera di Milano", aprile 1961, a. XIII, pp. 133-36; *Notizie italiane*, "Notiziario Cnrn", maggio 1960, a. VI, 5, pp. 406-410.

[97] *Notizie italiane*, "Notiziario Cnrn", luglio 1960, a. VI, n. 7, p. 625. In September 1960, the CNEN set up a similar pavilion in Bari, on the occasion of the Twenty-fourth Levante Trade Fair.

resulted from the direct selection of mutants or — as in the case of the most successful wheat variety, the "Creso" — from continued cross-breeding with these mutant cultivars or with other mutant lines.[98] The international success of the Casaccia mutagenesis programme has given rise — in the reconstructions and testimonial accounts of its protagonists — to a retrospective reading mostly marked by two elements: on the one side, a linear, nonconflicting and teleological interpretation of the historical process, a kind of *whig history* that can be summarised in the words "from Strampelli to the Green Revolution";[99] on the other, a reading focused on the centrality of the gamma field, in all its technological materiality and iconographic force.

Drawing the attention on the politico-institutional and scientific-disciplinary genesis of the gamma field in Italy, in this essay I have tried to deconstruct this retrospective narrative by offering a different interpretation.

First, I have considered radioinduced mutagenesis as "hybrid knowledge",[100] in which the transnational circulation of scientific knowledge was strictly linked to the asymmetric dimension of the coproduction of US hegemony in Western Europe. My reconstruction of the Pisan origins of the gamma field — and of the relations with the USAEC — bridges the international Cold War context and the local dynamics of discipline-building with regard to plant genetics in Italy.

Second, the essay demonstrates that the centrality of the gamma field was largely "constructed": that is, it was a symbolic and iconic rather than a scientific-technological centrality. The main wheat mutants that were patented at the Casaccia were obtained through x-rays and thermal neutrons radiated on seeds, not through gamma rays. Yet, the gamma field was always there: the centre of gravity of a scientific community and of a network of researchers who made reference to it, and at the same time the iconic synthesis of a technological artefact and a research model that was repeatedly immortalised in the CNEN's magazines and documentaries. If, on the one hand, the gamma field materialised the *Atoms for Peace* programme by making the political as well as scientific connection with the United States visibly tangible, on the other hand it announced a new modernity for Italy during the economic boom, placing nuclear energy at the service of agriculture and food science, in a powerful combination of tradition and futurism. Humans expanded their control over nature: spaghetti were becoming "atomic".

[98] Luigi Rossi, *Il miglioramento genetico del grano duro in Casaccia. Il grano Creso*, "Energia, ambiente e innovazione", 2010, n. 6, pp. 46-52.

[99] For example, G.T. Scarascia Mugnozza, *The contributions of Italian wheat geneticists: from Nazareno Strampelli to Francesco D'Amato*, in Roberto Tuberosa, Ronald L. Phillips, Mike Gale (eds.), *In the wake of the double helix: from the Green Revolution to the Gene Revolution*, Bologna, Avenue media, 2005, pp. 53-75.

[100] John Krige, *Hybrid knowledge: the transnational co-production of the gas centrifuge for uranium enrichment in the 1960s*, "British Journal for the History of Science", 2012, vol. 45, n. 3, pp. 337-357.

"We were the only ones in Europe",[101] is the proud statement that resurfaces in the voices and memories of the protagonists of the time. It doesn't entirely reflect the truth, though. Italy was certainly the first among the six member states of the EURATOM, but at the start of the 1960s other gamma fields were active in Sweden, the UK, Spain and Czechoslovakia. Yet, in the midst of this inconsistency a creative amnesia seems to emerge, where the political centrality and the symbolic force of the Italian gamma field resurface like the visible traces of a story still largely unknown.

[101] Author's interview with Alessandro Bozzini, Basilio Donini and Luigi Rossi (Rome, FIDAF headquarters, 23 October 2017).